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MEMORANDUM FOR THE RECORD

SUBJECT: Project Ring Around

REFERENCE: TA-37-500019-2, 3 October 1967

NRO REVIEW COMPLETED

1. Color film has been used in various collection systems, in both operational and test missions. Reproduction copies can vary widely in color balance, depending upon the processing and desired results for interpretation. To formulate a meaningful PI opinion on the color gradation and density of duplicates preferred which may be used as standards for color duplication, NRO initiated Project Ring Around. The processing facility provided a series of color reproductions to NPIC. In NPIC, both PAG and TID conducted a coordinated test to determine the preferred reproductions for exploitation.

2. The referenced document is a report of the test, prepared by the processing facility. The test produced beneficial data that will govern reproduction standards in the future. As a result of the test, it was concluded that:

a. is an acceptable emulsion for color reproductions.

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b. Less density is desired.

c. A slight shift in the "aim point" color balance is preferred.

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**Declass Review by
NIMA / DoD**

Deputy Chief
Technical Intelligence Division

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13 pages

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SPECIAL REPORT

"PROJECT RING-AROUND"

PREPARED BY: 25X1A

[Redacted Signature Box]

APPROVED BY:

[Redacted Signature Box]

DATE: 3 October 1967

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TA 37-500019-2

20 September 1967

SPECIAL REPORT

"PROJECT RING-AROUND"

20 SEPTEMBER 1967

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SPECIAL REPORT

20 SEPTEMBER 1967

TITLE: Project Ring-Around

TASK/PROBLEM:

1. Provide for photointerpreter evaluation, a series of aerial color photographic reproductions showing graduated color and density variations, from which preferences may be subjectively selected. Analyze these data and translate into objective terms which may be used as standards for color aerial reconnaissance duplication tasks.

SUMMARY:

2. Reproduction standards for color aerial reconnaissance photography have heretofore not been specified with universal agreement. Color balance of the duplicate transparencies has been particularly troublesome, with lesser disagreement on highlight or overall density. In an effort to determine what the ultimate user of the material requires, or at least desires, series of duplicates were prepared which contained controlled color and density variations. Ten typical aerial scenes, selected by the customer, were used to prepare each "color ring-around" and density series.

3. Using a standardized test procedure, 34 photointerpreters evaluated the coded test duplicates and selected individual preferences for color and for density. These subjective data were then reduced to objective terms by means of small-spot integral densitometry.

4. Test scenes selected by the customer were largely industrial-residential complexes. The preferred overall density for the average of these scenes, and the average of all viewers, was 0.90 D as measured through the red filter of a standard Type A transmission densitometer. The preferred color balance at this red density is 1.18 D through the green filter and 1.55 D through the blue filter. Because the measured color balance changes for subjects at other red-filter densities, a calibration curve has been prepared relating the preferred three colors.

INTRODUCTION:

5. The appropriate color balance for reproductions of aerial reconnaissance photography has long been a subject for conjecture. Because the original photograph is often, of necessity perhaps, of a color balance quite far from "normal" in the personal-photography sense, some have believed that the reproduction color balance need only lie anywhere between that of the original and "normal". For mensuration purposes this may be true. However, there is increasing evidence that photointerpreters in general need, or at least desire, a color balance which will show all commonly-recognizable objects in what is considered to be their "true" color. It is the purpose

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of the study herein reported to survey the customer wishes on both color balance and density of aerial photography reproductions, and to translate such subjective information into objective terms of immediate practical usability. Other independent studies of a related nature now underway should, in the future, lead to more sophisticated equipment and procedures to accomplish the same ends on an automated mass-volume basis. For the present, standard manual three-color densitometry is used and can provide a large measure of standardization of this troublesome subject.

DISCUSSION:

6. High altitude aerial photography is often hampered by the presence of haze, smog, dust, etc. which has the effect of filtering out and scattering some of the light which should make up the total imagery. Filters are commonly used to penetrate these interfering foreign layers, but they introduce their own distortion of the original imagery. The ultra-violet absorbing filter usually used for color photography results in a yellow color balance on the original film which is very unnatural in terms of typical amateur photography. However, if sufficient red, green, and blue light has reached the film during exposure, it may be theoretically possible to selectively print for color balance the original film so that the three-color relationship for readily-recognizable subjects is brought back almost to that which is normally perceived at ground-level viewing. Practical considerations limit the degree to which this may be accomplished, and there has been considerable disagreement on the need or desirability of doing so in the first place.

7. Tone reproduction studies and other purely objective procedures should ultimately spell out the answers to the current questions on acquisition and reproduction requirements. Until some of the inconsistencies of some of these evaluation techniques can be resolved, and the interrelationships better understood, the subjective requirements of the ultimate users of the aerial photography must fill the void. We have attempted in this study to provide a large group of these ultimate users a selection of typical color reconnaissance photography from which individual preferences for color balance and density could be subjectively selected. The results of their efforts have been compiled and translated into the one objective procedure which is currently readily available: three-color manual integral densitometry. More sophisticated methods and instrumentation are in the offing, but are not yet suitable for practical application.

TEST PROCEDURE:

8. A typical high-altitude color original film, identified as [redacted] was selected by the customer for use in this study. Imagery on this film was judged to be of high quality, but because of the camera filtration which had been applied, the color balance was roughly equivalent to at least a CC .40 yellow to yellow-green from ground-normal. The duplicate which

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originally had been supplied to the customer had some compensation for this excessive yellow balance, but was still judged to be approximately CC .20 yellow from normal. It has not yet been established the extent to which this condition restricted or otherwise hindered the photointerpretability.

25X1D 9. Using original film [] a new color balance for duplication was determined which would appear more nearly "normal". This was done first by purely objective means through densitometry of concrete objects for which considerable reflectance and transmission density data had previously been generated. Because this color balance appeared bluer than was considered to be "normal", a shift toward a yellower color balance was subjectively induced. This new "reference" color balance is approximately CC .20 bluer than the duplicate originally supplied to the customer. Using the reference as the mid-point of a color series, duplicates were made which deviated by a CC .05, .10, and .20 in each of the six color directions; i.e., red, green, blue, cyan, magenta, and yellow. Ten scenes as selected by the customer were so prepared and sent to him for evaluation. Additional density series, at a single color balance, were similarly prepared.

25X1D 10. The test scenes selected by the customer contained a wide variety of subject matter. Arid desert land, temperate forest and agricultural areas, and semi-tropical and coastal lands were represented. Included in these formats were cities and towns, industrial and rail facilities, and other specific targets of the type which might be of strategic interest. Due to the acquisition system used, each [] test sample represented upwards of [] land surface.

25X1D 11. The basic scheme for evaluating the color variation test material was to have each of many photointerpreters view a single sample under 7X magnification, and to similarly intercompare several samples. By the process of elimination and preferential selection, each photointerpreter would determine his first, second, etc., choices for color balance and for density, for each of the test scenes.

12. When the project was presented at the customer's shop, two practical problems soon became apparent. First, the overall color of a large format can subconsciously influence a viewer's judgment of detail color, so that unimportant imagery can induce false evaluation of target imagery. Second, it is difficult to shift one's viewing under magnification from one sample to another, and retain adequate detailed judgment so that consistency can be maintained. The farther removed two test samples are, physically, the more difficult is a valid evaluation.

13. Because of the practical difficulties encountered, it was decided by the customer that the test samples be reduced in size. Accordingly, out of the original ten large formats, thirteen specific targets were selected. These were extracted as one-inch square film chips, which were numerically coded as had been the original large formats. The chips were mounted in random sequence on transparent sheets in blocks of three chips across a row and three rows per grouping. It was thus easy to intercompare the image charac-

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teristics of various color balances because of the proximity of the selected samples.

14. The detailed procedure by which the entire test was conducted is contained in written instructions provided to the customer (Appendix I). Some of the parameters which received particular attention were: predetermination of each photointerpreter's color perception, standardized viewing conditions (same magnification, illumination source, inspection sequence, etc.,) and coded sample identification to avoid color-label influence. Therefore, within practical limitations, this was a "controlled" test.

15. There was one deviation from the planned test procedure which the customer elected to retain: the transparency illuminators in the customer's shop have a color temperature averaging around 10,000°K instead of the recommended 4,400°K. Because of the fluorescent light source, which does not have a continuous spectral emission, the indicated color temperature is only an approximation. The apparent color is considerably bluer than the recommended source. This discrepancy is acceptable as long as the illumination remains as defined and indiscriminate intercomparisons are not attempted.

16. Thirty-four photointerpreters in the customer's shop performed the prescribed evaluation of the thirteen series of color balance and density variations. Each one indicated his first through fifth choices for color balance, and first through third choices for density, for each subject. The preferences were expressed as "chip numbers", because no other identification was provided during the test. These data were then summarized into frequency tabulations, which were forwarded to the contractor for evaluation. (Fig. 1)

17. The entire array of one-inch film chips was also returned to the contractor. Because it was the goal to relate customer subjective preferences to some objective evaluation, the most frequently selected chips were submitted for densitometric determinations. Manual integral densitometry is the only system currently available for immediate practical application. Therefore, the selected chips were read on [redacted] densitometers, using Status "A" filters and both 1mm and 4mm apertures. Replication was employed to improve the validity of the data so generated. A specific small spot was preselected from within each one-inch square subject area, and every effort was made, manually, to measure this same spot each time densitometry was performed. Because each millimeter of film displacement in the densitometer represents approximately [redacted] of ground subject matter, any slight error in repositioning the chip could result in a significant change in the imagery being measured. As in actual mission experience, however, there is no assurance that any single spot is more representative of the scene than any of the adjoining spots. This inherent variability, therefore, is troublesome but an inescapable part of aerial photography evaluation.

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TEST RESULTS:

18. The customer-selection frequency tabulations (Figure 1) show that no single color balance received a clear majority of preference. Because

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deviations of .05 Log E are difficult to perceive under magnification, some of this variability was to be expected. Those preferences which deviated from the apparent mean by more than this amount, and particularly in a color direction contrary to the general trend, further emphasize the imperfect human element in this type of study.

19. When the customer-selection data are decoded into Log E deviations from the reference, the first, second, etc., choices can be graphically shown as on Figure 2. In spite of the variability mentioned above, it is interesting to note that over two-thirds of the first three preferences fall within .05 Log E of the reference, and that there is a strong indication of preferred color direction. The data, therefore, do assume meaningful proportions. Note that each major division on the graph (Fig. 2) is only 0.05 Log E.

20. The densitometric data can also be presented in a graphical manner. Different subjects, even of the same general type such as "factories", will have different total densities. Furthermore, the relationship of red to green to blue light reflectance changes for various overall densities. Therefore, for each measured chip of a given preference level ("first choice", for example), the red-filter density was used as the abscissa for the graphical presentation, and the magnitudes of the blue-filter and the green-filter densities above the red filter density were the ordinates. All of the points so obtained for the Reference Chips are shown for illustrative purposes in Figure 3. The smooth curves drawn through the scattering of points represent the best estimates of the "true" relationship of the three colors.

21. In a manner as described above, the first three customer choices for color were individually plotted, treating the lmm and the hmm densitometer aperture data separately. These six graphical presentations were so similar that a single composite graph has been drawn, as shown in Figure 4. This, then, is the calibration which describes the average customer color preference for the types of subject matter used in this study, in terms of the mode of integral densitometry currently used in the contractor's shop.

22. Densitometry of the density-preference film chips did not lead to as well-defined a correlation as did the color study. Statistical evaluation of the data was made, and a set of densitometry values was extracted as shown on the color-calibration curves, Figure 4. However, because the subject matter available for this study varied so much in "minimum" and in "average" density, the figures presented here as tentative aim values must be viewed as "first approximations" only. Subjective adjustment may be necessary in actual mission application.

CONCLUSIONS:

23. Thirty-four experienced photointerpreters have evaluated color and density variations introduced into the reproduction of 13 aerial color reconnaissance scenes. From their subjective conclusions, objective data have

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been extracted which specify the preferred color balance and density for similar photography. When expressed as Status "A" integral density values, these data provide the standards, within approximately .05 Log E, by which future aerial color reproductions may be made. These data also may be directly applicable to, or at least serve as approximation for, other acquisition systems where scale factors, subject matter, acquisition mode, etc., are quite different.

24. Duplication specifications, as determined by this study, may be restated as follows:

Original Film: [REDACTED]

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Duplication Film [REDACTED]

Process: Modified ME-4 (lowered contrast for [REDACTED])

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Densitometry: [REDACTED] Status A filters, 1mm or 4mm apertures

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Aerial Subject matter to be measured: Industrial or residential complexes

Average Preferred Densities:

Red filter 0.90

Green filter 1.18

Blue filter 1.55

25. For subjects lighter or darker than the "average", refer to Figure 4 for the curves relating the three color preferences.

RECOMMENDATIONS:

26. Verification of the conclusions of this study should be made by utilization wherever color aerial film duplications are to be made. By documenting failures as well as successes, refinement in the technique can be made. Similarly, effects of scale factors, available subject matter, etc., can be noted for further validation of the procedure. Assuming that fundamentally the approach used here is valid, it will be essential to pursue advanced instrumentation if mass-production will ultimately be required.

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APPENDIX I

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Suggested Instructions for PROJECT RING-AROUND Preference Survey:Basic Provisions:

1. Provide a viewer or viewers capable of handling at least five 25X1A transparencies.
2. The color temperature of the viewer should be $4400^{\circ}\text{K} \pm 200^{\circ}\text{K}$ and the intensity of the light source should be 450 ± 50 foot candles.
3. It is recommended that masks be used to reduce extraneous light from the viewer.
4. Incident room light should not exceed 10% of transmitted light from viewer.
5. Evaluation should be done at 7X magnification.
6. In order to obtain meaningful data from this color preference survey, a simple screening test should be given to separate persons with defective color vision from those with normal color vision.

It is suggested each participant in the survey be screened for color blindness by customer personnel using the 25X1 Pseudoisochromatic Plates Test and procedures.

If a color blind person is included in the survey, it should be so noted on the score sheets so that his evaluation can be given appropriate weighing in the statistical analysis of the data collected.

7. A minimum of 10 evaluators with normal color vision are suggested to evaluate all the samples in the ring-around.
8. All evaluators should be given identical instructions.
9. Each evaluator should independently judge the series.

Procedures

1. Date the score sheet. Assign a number to each evaluator and record in upper left corner of the test sheet, also indicate color blindness - Y he is color blind or N he is not color blind.
2. Select one of the ten boxes of duplicates.
3. Note revolution and frame number and remove all the duplicates in the 30 series.

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APPENDIX I (continued)

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4. Instruct the evaluator to examine under 7X magnification all 21 color duplicates and select 10 most acceptable for color balance. Then rank these 10 in order of his color preference.

Evaluators may use different methods of ranking for color preferences. The method used is immaterial, providing a 1st, 2nd, 3rd, etc. preference is indicated.

5. Record under the appropriate column of the score sheet, in order of his preference, the number following the words PROJECT RING-AROUND.
6. Ask the evaluator to indicate which, if any, of the 21 duplicates are acceptable for color balance.
7. Circle those numbers so indicated on the score sheet.
8. Remove the 21 duplicates and display the 7 duplicates in the 30 series.
9. Ask the evaluator to judge density in order of preference and record these 7, two-digit numbers on the score sheet in the density column.
10. Follow procedures 2 thru 9 for each of the other sets of duplicates.
11. It is suggested the same evaluators repeat the exercise at a later date, a day or so later, using the same procedure as outlined above.

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01	2454421441534		REF
02	4435314332	5	.05R
03	4124344	28	.05G
04	2554151133	30	.20C
05	335342452243	32	.05C
06	11354155	23	.10Y
07	1252113512	37	.10G
08			.20B
09	FILM CHIP IDENTIFICATION CODE		.10R
10	412125551214	35	.10B
11	445		.20G
12	221		.20Y
13	33121333325213	49	.05B
14	- NOT USED *****		.20M
15	2541545351145345	39	REF
16	- NOT USED *****		.20R
17	5132422255321	41	REF
18	12524311234	38	.05M
19	- NOT USED *****		.10M
20	433332315221		.10C
21	2155345542		.05Y
30	3332332322223		REF
31	3		+ .10
32	211222323232121232332321112		- .10
33	122111111113121121111222111		- .20
34	333		+ .20
35	3132233233132333332		+ .05
36	3132233233132333332		- .05

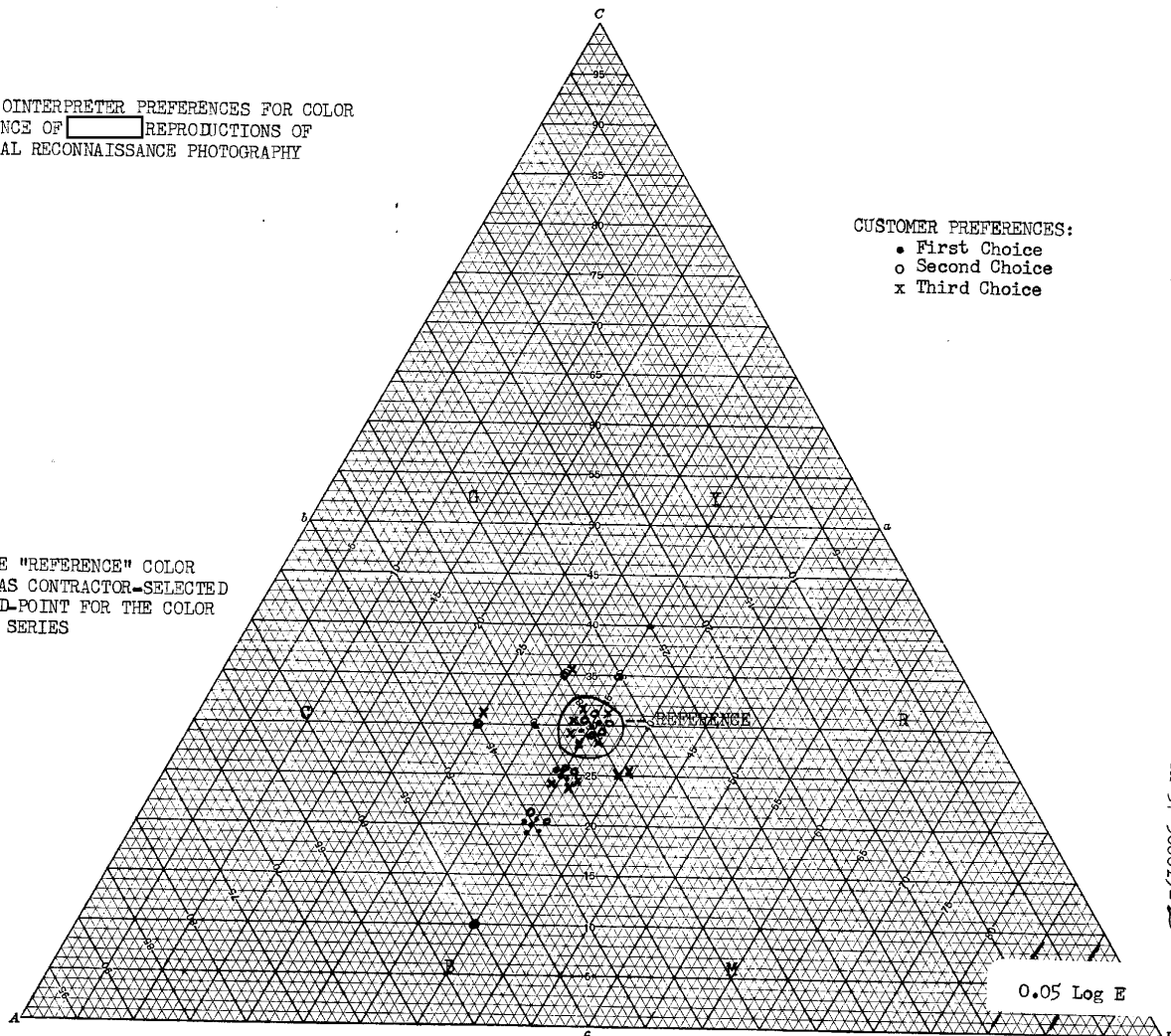
FIGURE 1

PHOTOINTERPRETER PREFERENCES FOR COLOR
BALANCE OF REPRODUCTIONS OF
AERIAL RECONNAISSANCE PHOTOGRAPHY

CUSTOMER PREFERENCES:
• First Choice
○ Second Choice
x Third Choice

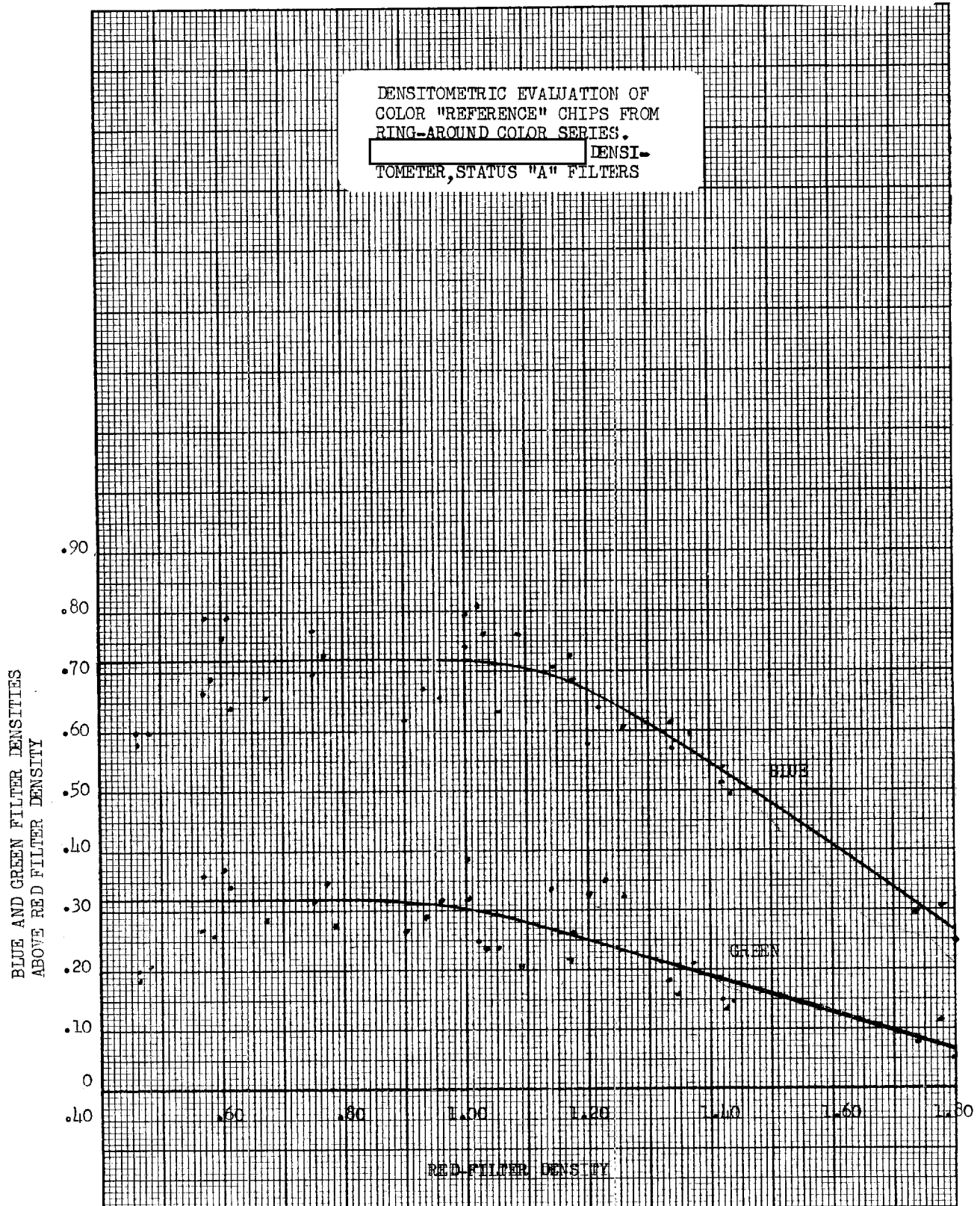
FIGURE 2

NOTE: THE "REFERENCE" COLOR
BALANCE WAS CONTRACTOR-SELECTED
AS THE MID-POINT FOR THE COLOR
VARIATION SERIES



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FIGURE 3

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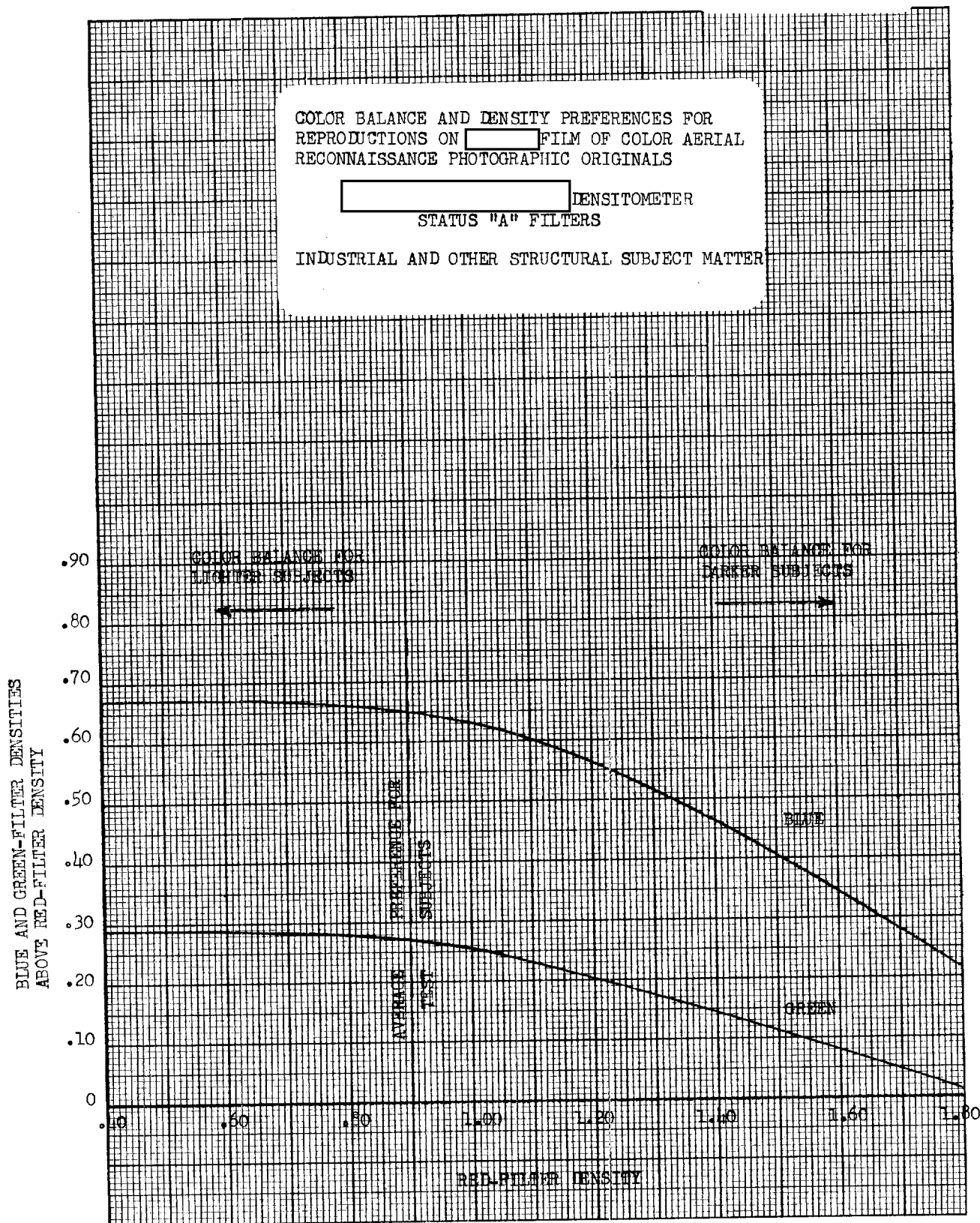


FIGURE 4

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CENTER ROUTING SLIP

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FROM	Approved For Release 2003/07/14 : CIA-RDP78B04767A000100160001-8
C/TID	DATE 16 Nov 67

TO	INITIALS	DATE	REMARKS
DIR	5 <i>act</i>	11/20	Sent to you for information only. To let you know Project Ring Around has been completed, evaluated & should bear fruit in future color film processing for NPIC. <i>S. Jo</i>
DEP/DIR	4 <i>pm</i>	11/20	
EXEC/DIR	3 <i>act</i>	11/17	
TECH ADV	2 <i>act</i>	11/15	
SPECIAL ASST	1 <i>M</i>	11/16	
CH/SS			<i>Please send back to TWC before TID filing.</i>
ASST FOR P&M			
ASST FOR OPS			
ASST FOR PA			
ASST FOR TD			
CH/CSD			<i>Under reorganization this should be returned to [] for filing. esp.</i>
CH/IPD			
CH/PD			
CH/PSD			
CH/TID	<i>#</i>		
CH/IAS/DDI			<i>Good job. @</i>
CH/DIA/XX-4			
CH/DIA/AP-IP			
CH/SPAD			
LO/CGS/CIA			
LO/NSA			

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